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IMPORTANT SUGAR-BEET BY PRODUCTS *and Their* UTILIZATION

THE beet-sugar industry has several byproducts that are of importance to agriculture. In harvesting sugar beets the tops, which constitute about one half of the weight of the marketable roots, are cut off in the field. In the processing of the sugar beet into sugar, pulp and molasses are produced as byproducts. These byproducts are important feeds for fattening cattle and sheep in the areas where they are produced. They are also used advantageously in a variety of rations for dairy cattle and to some extent in feeding other livestock, such as horses, swine, goats, poultry, and rabbits. In general, the dry matter of these byproducts has practically the same feeding value as that of grain when they are fed in properly balanced rations. Lime cake, another byproduct of beet-sugar manufacture, serves the same purpose as ground limestone in growing legumes that do not thrive in an acid soil, and in improving the texture of the soil.

The different forms in which these byproducts are available and their value for livestock feeding and soil improvement are discussed in this bulletin. Specimen rations for feeding different classes of livestock are given on pages 27 to 29, inclusive.

Supplementary information relating to the production and feeding of sugar-beet byproducts may be obtained on request from the United States Department of Agriculture, Washington, D.C., and from the agricultural experiment stations located in the various sugar-beet producing States.

This bulletin supersedes Farmers' Bulletin 1095, Beet-Top Silage and Other Byproducts of the Sugar Beet.

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IMPORTANT SUGAR-BEET BYPRODUCTS AND THEIR UTILIZATION

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IMPORTANCE OF SUGAR-BEET BYPRODUCTS IN LIVESTOCK FEEDING

THE BEET-SUGAR INDUSTRY produces directly from the sugar beet several byproducts—beet tops, pulp, and molasses—which constitute an important source of livestock feed. Abroad, through more than a century of sugar-beet growing, the value of these byproducts has become increasingly appreciated, and they have been efficiently utilized. In the United States the value of these byproducts has not as yet been fully realized, and in some localities full advantage has not been taken of these available feeds. A more general recognition of the true worth of the byproducts of the sugar beet is necessary for their effective utilization. With the 1931 production of beet pulp valued at approximately $3,000,000, the yield of beet tops if utilized for feeding worth practically as much more on the basis of acreage planted, tonnage of beets produced, and feeding value, and with beet molasses estimated at about $400,000, the aggregate amounts to more than $6,000,000 annually. This sum, as compared with $81,812,489, which was the total value of the beet sugar produced in this country in 1931, as reported by the Bureau of the Census, affords a basis for judging the importance of these byproducts.

[1] Acknowledgment is made of indebtedness for assistance in assembling information on sugar-beet byproduct utilization to H. E. Brewbaker, C. E. Cormany, S. B. Nuckols, and to other members of the agronomy unit of the Division of Sugar Plant Investigations; to S. H. Hastings, Beyer Aune, Daniel Hansen, J. O. Holden, and other members of the Division of Western Irrigation Agriculture; to D. A. Spencer and A. T. Semple of the Animal Husbandry Division, Bureau of Animal Industry; to J. B. Shepherd and G. Q. Bateman, of the Division of Dairy Cattle Breeding, Feeding, and Management, Bureau of Dairy Industry; to E. J. Maynard, Utah Agricultural Experiment Station; and to G. E. Morton, B. W. Fairbanks, and others of the Colorado Agricultual Experiment Station. The American Beet Sugar Co., The Amalgamated Sugar Co., The Great Western Sugar Co., The Holly Sugar Corporation, The Utah-Idaho Sugar Co., and other beet-sugar companies furnished information pertaining to their districts. The assistance received from these sources is gratefully acknowledged.

In addition to this domestic production, 41,224 tons of dried beet pulp, with a declared value of $638,215, were imported in 1931 for consumption.

As a further indication of the value of sugar-beet byproducts, attention is called to the fact that 3 of the 4 principal lamb-feeding sections in Colorado correspond to the principal beet-producing sections. In these 3 sections are fed approximately 30 percent of all lambs fattened in the United States during the winter feeding season.

Carefully conducted tests have been made by several of the State and Federal experiment stations in determining the value of sugar-beet byproducts when fed to various classes of livestock. It is the purpose of this bulletin to bring to the attention of the reader some of these results, together with the generally favorable experiences of the already large body of feeders of livestock successfully using these byproducts, so as to encourage a general appreciation and careful and efficient utilization of the beet tops, pulp, and molasses in rations for the economical feeding of livestock.

TOPS

Sugar beets are purchased from the grower by the beet-sugar company primarily for their sucrose content. In the crown of the beet certain salts accumulate that tend to interfere with the recovery of sugar from the juices and, therefore, the grower is required to remove that portion of the beet to which the leaves are attached. This discarded portion, which is left lying on the ground in the field when the beets are harvested, is known as the beet top or tops. It consists of about one third crown and two thirds leaves. Its initial moisture content ranges from 75 to 90 percent. Assuming the average initial moisture content of the tops to be about 85 percent, there would be about 300 pounds of dry matter in a ton of such tops.

The proportion of the green weight of the top to the root varies with the locality and with the season. In the irrigated area usually these tops will range in weight from 30 to 70 percent of the marketed weight of beets produced, depending on fertility of the soil and relative freedom from defoliation caused by hail, insect pests, and fungous diseases. In the humid area the tops may constitute a higher proportion of the beets produced. Because of this wide range, and also because of the tendency of the tops to increase or decrease in weight, depending on climatic conditions and the period of harvest, the general practice of purchasing them on a basis of tops to tons of beets produced has been resorted to in those areas where a ready market exists for this commodity. Assuming that the weight of the tops amounted to 60 percent of the marketed weight of the beets produced, this would mean that a 15-ton beet crop would produce 9 tons of green or fresh tops.

HANDLING

An increasingly popular field practice is to throw the beets into windrows before topping them (from 12 to 16 rows of beets are windrowed together), and then to cut the tops off with a sharp knife. In some cases, after the beets have been delivered these tops are placed in small cocks not larger than an inverted washtub and al-

lowed to cure. When cured, they are hauled to the feed lot and are either stacked or fed as hauled (fig. 1). In other cases they are pastured by cattle or sheep in the field (fig. 2). Under present conditions, the hauling of tops fresh from the field is not extensively prac-

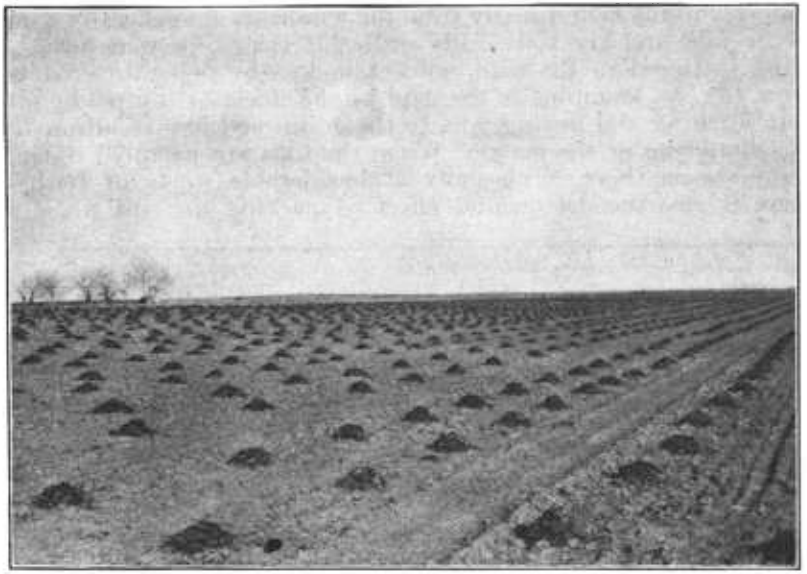

FIGURE 1.—Beet tops piled in the field, affording a readily accessible supply of feed

FIGURE 2.—Pasturing sheep on beet tops left scattered in the field.

ticed. In fact, in several of the western beet-growing areas the ensiling of tops has been practically discontinued. There are still, however, some beet growers and feeders who prefer feeding beet tops as silage to feeding them in any other way.

Considerable progress has been made in some of the beet-growing sections of the United States in caring for and feeding tops. In one area where topping the beets from windrows is the prevailing practice, more than 80 percent of the tops are piled when partially dry and hauled as needed to the feed lot. Tops that have been piled properly in the field directly from the windrows are generally a much better feed and are more fully utilizable than tops that have been lying scattered in the field, subject to loss by being covered with snow (fig. 3), trampled in the mud by the stock, or injured by alternate leaching and drying, and to the additional loss resulting from the shattering of the leaves. When the tops are pastured during a rainy season there is not only a considerable waste of feed, but there is also the detrimental effect of packing the soil when wet,

FIGURE 3.—Tops left scattered in the field and pastured under adverse weather conditions, resulting in loss in feed value.

which often results in a cloddy condition that is difficult to overcome in the spring (fig. 4). In some fields, the tendency for the soil to wind-drift is increased by pasturing in the field. Where weather and soil conditions are favorable, however, and if the field is not going to be fall-plowed, pasturing the tops may sometimes be justified. This is especially so in cases where beets have been grown on nematode-infested land. From such fields the tops should never be hauled.

Some beet growers prefer to stack the tops as soon as they are thoroughly dried, to avoid losses in feeding value which would occur if they were left in the field in piles. In some cases the tops are stacked even though not fully dried, and a 2- or 3-inch layer of straw is alternated with a 6- or 8-inch layer of tops. An efficient size of rick for convenience in feeding is one which is about 8 or 10 feet wide, about 12 feet long, and 10 feet high. An ordinary hay knife is used to cut the stacked tops. Tops properly stacked, even though

3 years old, have been relished by livestock. Where livestock is not available, the immediate plowing under of the green tops is advisable, as the tops have considerable value as a green manure.

FEEDING

As beet tops are quite palatable when properly handled and contain strongly cathartic salts, they should be fed with care, and supplementary feeds that counteract the laxative effect used wherever practicable. Inasmuch as beet leaves contain considerable oxalic acid, they are dangerous when fed in large quantities to pigs and horses. The amount fed should not exceed 1 pound of fresh green

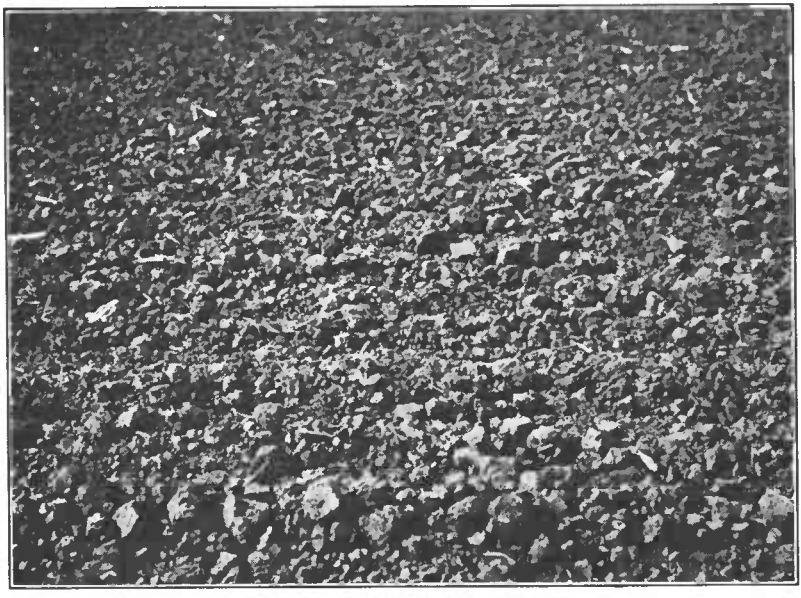

FIGURE 4.—Texture of soil detrimentally affected by livestock being allowed access to the field in wet weather. In spite of considerable reworking, a poor seed bed was obtained the following spring.

tops per 100 pounds of live weight. Fermentation in the paunch of ruminants destroys part of this acid. However, too liberal feeding may result not only in scouring but also in indigestion. German investigators have observed that 1 ounce of precipitated chalk fed with 50 pounds of leaves will counteract much of the unfavorable effect of the acid.

In making silage from beet tops produced on sandy soil, care should be taken to shake out as much sand as possible in handling them, to avoid digestive trouble resulting from too much sand being incorporated in the silage.

Experiments conducted by the Colorado Agricultural Experiment Station show that an average acre of tops is equal in feed value to a ton of alfalfa hay, and that a ton of dried tops and a ton of alfalfa hay are equal to 2 tons of alfalfa hay fed alone, in putting gains on steers during the first 6 weeks of the fattening period.

Generally where the tops are pastured in the field, a fixed rate per day per animal is assessed, varying with the class of livestock pastured and the prevailing prices for other feed.

In regard to the general feed value of tops that have been carefully handled in an effort to conserve their nutritive value, the Colorado Experiment Station stated in 1928 that, according to feeding tests, beet tops are worth about twice as much when fed in properly balanced rations as is commonly charged for them.

Many of the beet-sugar companies have large-sized feeding pens (see illustration on title page) located immediately adjacent to the factory grounds. Some of the beet-sugar companies also furnish their beet growers with cattle to feed on a "pound gain" basis, at a certain specified price per pound. Such a practice encourages considerable feeding of small groups of cattle by farmers who have the feed and the equipment but who lack the capital required for the purchase of cattle.

BEET TOPS FOR BEEF CATTLE

In order to use the tops to best advantage by grazing, enough cattle per acre should be used to clean them up fairly well in about 6 weeks.[2] Accordingly, an acre of beets yielding about 8 tons of tops would produce sufficient feed to graze two or three 2-year-old steers for 40 days. In addition, about 10 pounds of hay per steer per day should be fed. Under favorable conditions steers should gain about 1 pound per head daily. A heavier rate of grazing is desirable when fencing can be so handled that the cattle are confined to an area of tops they will clean up in a week to 10 days. Experiments conducted by the Colorado Station show the influence weather has on the utilization by animals in the pasturing of tops. Two-year-old steers pastured under ideal weather conditions required tops from only 6 tons of beets and 317 pounds of alfalfa hay to produce 100 pounds of gain at the rate of 1.9 pounds per head daily. The next fall, with severe storms, it took the tops from 24 tons of beets and 2,137 pounds of alfalfa to produce like gains at the rate of 0.6 pound per head daily. In the latter case most of the tops were wasted because of being trampled in the mud. The increased consumption of hay was due partly to the much lower rate of gain.

In a series of 3 tests in Colorado, in 1 bad and 2 good years, it paid best to haul the tops and feed in dry lot, but with normally only 1 bad fall out of 5 or 6, it would be more economical to pasture them.

BEET TOPS FOR SHEEP

In some of the sugar-beet-growing areas where sheep feeding is extensively practiced the tops are generally pastured in connection with grain and alfalfa stubble on a basis of 1 cent per head per day. The Colorado Station states that ordinarily the tops from 14 tons of beets, if there is little or no waste, will furnish feed for 1,000 lambs for 1 day. Where the lambs also have access to stubble land, the tops from 7 tons of beets and 1½ acres of alfalfa stubble and small-

[2] In pasturing beet tops or feeding them in dry lot, cattle should be watched rather closely to prevent their choking on the beet tops. This condition can be relieved by carefully inserting in the gullet a loop of smooth wire to remove the obstruction.

grain stubble should carry 1,000 lambs for 1 day. Lambs pastured or fed on tops and roughage should gain from 0.15 to 0.2 pound per head daily. In good weather lambs pastured on tops have made heavier and cheaper gains than lambs fed tops in dry lot. If tops are fed in dry lot, it is not good practice to feed them through panels, because the lambs pull many of the tops through, trample, and waste them. It is best to scatter on clean straw just what tops the lambs will clean up each day. The tops from a ton of beets fed with grain and alfalfa will replace about 20 pounds of grain and 100 pounds of alfalfa, provided there are no tops wasted.

Averaging the results of three consecutive lamb-feeding experiments at the Scotts Bluff Field Station, Mitchell, Nebr., the addition of beet tops to a fattening ration of alfalfa and equal parts of barley and dried pulp reduced the requirements of corn and dried pulp 14 percent, increased the rate of gain 15 percent, the appraised value nearly 4 percent, and the profit per lamb 40 percent.

At the Huntley Field Station, Huntley, Mont., in four consecutive experiments (1929–32) in fattening lambs, the addition of 2¼ pounds of choice-quality well-dried tops to a ration of 1.1 pounds of barley and 2.4 pounds of alfalfa hay increased the rate of gain 16 percent and reduced the hay consumed per lamb per day fully one third. In other words, 3 pounds of tops replaced 1 pound of alfalfa hay, reducing the alfalfa from 2.4 to 1.6 pounds and increasing the gain from 0.29 to 0.34 pound per head per day. There was no change in the barley consumption, and the sale price was practically the same.

BEET TOPS FOR DAIRY CATTLE

Feeding beet tops to dairy cattle has been attended with varying degrees of success, depending on the conditions of the tops when fed and the degree to which the after effects were noticed in the milk produced.

Opinion is divided as to the effect of feeding beet tops in tainting milk. Some dairymen maintain that when beet tops are allowed to become much wilted or dried before being fed, and then are fed in normal amounts after milking, no tainting of milk will result. Other dairymen advocate the feeding of fresh tops not to exceed 20 pounds per cow after milking with some supplementary feed and a little grain mixture to overcome some of the purgative effect of the beet tops. Still others claim that regardless of precautions taken, that feeding of beet tops and wet or siloed beet pulp to dairy cows will tend to produce off-flavored milk. Everything considered, however, experience indicates that the feeding of fresh tops and wet or siloed pulp in moderate amounts with some supplementary feed after milking, will reduce to a minimum this objectionable tendency.

The value of pasturing beet tops as compared with feeding them in the dry lot is seen in the following experiences. In one instance 18 cows were pastured on tops, and the production of milk dropped shortly after the cows began pasturing and did not return to normal until after the tops had all been pastured. In the second case, the cows were dry-lot fed, at first on a small amount of green tops, and later one half the hay ration was replaced with tops. These cows gained in milk flow with the beginning of feeding beet tops and

maintained a normal flow during the winter. Estimating the value of the tops at 25 cents per ton on the basis of beet tonnage produced, the pastured tops cost $2.10 per month per cow, and $1.30 per cow per month when fed in the dry lot. Besides this saving in feed cost, there was a substantial difference in average butterfat production in favor of dry-lot feeding. There was a production of 304 pounds of butterfat per cow fed tops in the dry lot, as compared with 278 pounds per cow pastured upon the tops.

In another instance, a dairyman fed in a ration beet tops from 66 acres that yielded 1,196 tons of beets. The sale value of tops in this case, also on the basis of 25 cents per ton of beets produced, was $299, or $4.53 per acre. In actual feed value, however, this quantity of tops replaced 99 tons of alfalfa hay valued at $7 per ton, giving a return of $10.50 per acre for beet tops.

Some dairymen state that when beet tops are pastured while in a fresh condition they have the same replacement value as fresh pulp, while others state that if the dairy animals were fed beet tops alone the tops would replace from one half to all of the alfalfa hay for a short time without bad results. Those dairymen who feed tops in the feed lot prefer this method of feeding because less scouring of the cattle occurs.

PRESERVING BY DRYING

Many inquiries have been made by sugar-beet growers and feeders of livestock relative to artificial drying of sugar-beet tops. As there are numerous cases of artificially drying alfalfa and other crops, and as such a process, properly controlled, produces feed as good as or better than hay naturally dried, there seems to be no reason why artificial drying should not be applied to beet tops, if it can be done economically.

Preservation of sugar-beet tops by drying is practiced in several of the beet-growing areas in Europe, and much progress has been made in developing machinery to handle this byproduct. After most of the adhering soil has been removed by washing, the tops are chopped up, to insure even drying, then pressed to about 25 percent dry matter, and dried (in kilns very similar to those used in the factory for drying the pulp) to a moisture content ranging from 10 to 15 percent. The dried product is highly esteemed in Europe, has a ready market, and in feeding value is generally considered equal to oats.

PRESERVING BY SILOING

While in certain areas beet tops are fed generally, either in a fresh state or fully cured, there are other areas where, because of weather considerations, it is not possible to feed them in either of these ways and where siloing is the most practical method of handling them. The Colorado Experiment Station has found with regard to beet-top silage that when beet tops are ensiled in an effort to conserve them and furnish a succulent feed during the whole feeding period, although the silage gives fairly good results for the short preliminary feed, it is impractical for the entire feeding period. It was further found that beet-top silage, like most protein silages, spoils quickly when exposed to the air and causes digestive disturbances

and scouring, especially when the weather becomes warm. Piling tops in small piles in the field and pasturing or hauling and feeding them in dry lot was more satisfactory than when the tops were ensiled. On account of loss in moisture in the ensiling process, 100 pounds of beet-top silage contains about one third more dry matter and therefore more feeding value than found in a similar quantity of fresh tops.

On the other hand, according to one authority, it has been found in Germany that sugar-beet tops, once harvested, should be fed, as far as possible, in a fresh condition, and such excess as cannot be fed fresh should be siloed, on the theory that a correct process of siloing will not result in losses higher than those that are incurred by storage in the field.

Some sugar-beet growers, especially in the humid area where it is difficult to cure beet tops in the field, find it profitable to silo the green tops, either with or without straw. The soil should be removed from the tops before they are placed in the silo. This is an important precautionary measure, as compacting of silage in the stomach of the animal is almost sure to follow when there is much soil in the silage. As horses seem especially affected by such compacting, as a rule no beet-top silage is fed to them.

FIGURE 5.—Trench silo showing shallow excavation in which beet tops are piled to be conserved by the trench-silo method. The dimensions of the silo vary according to quantity of tops to be siloed.

When the tops are fresh and green they can be alternated in the silo with layers of straw. When the tops are dry they should be siloed without the addition of straw, as a much more thorough packing of the siloed mass is required where straw is used. Good results have also been reported in using silage made from alternate layers, about 6 inches thick, of beet tops and wet beet pulp.

While the ordinary stave or concrete silo can be used successfully for siloing beet tops, the more common practice is to silo them in an

ordinary trench or pit silo located conveniently near the feed lot. The depth of such a silo will depend on adequate drainage. In soils provided with good underdrainage (fig. 5) the silo can be made deeper than in soils that have a high-water table, necessitating the construction of the silo aboveground. If the silo is constructed aboveground the wastage of feed is greater.

The tops (which as a rule are not run through a silage cutter before being placed in a trench or pit silo) are hauled to the silo, which is filled as quickly as possible (the mass being sprinkled with water if necessary), tightly and evenly packed by driving the teams and wagons over the layers, and the top and sides sealed either with a heavy layer of wet beet pulp if available, or with an 8- to 10-inch layer of fine, chaffy straw. In a period of 5 to 6 weeks the mass has fermented sufficiently to be used as needed. Some beet growers silo the beet tops in stave or concrete silos by running the particular roughage they have available and the beet tops through a silage cutter in the proportion of 75 percent by weight of tops to 25 percent by weight of the other roughage. Several of the growers use from 3 to 5 pounds of salt per ton of beet tops at the time of siloing to make the silage more palatable and to improve its quality. When the silage is ready to feed from a trench silo, a large hay knife or sharp spade can be used and the silage cut across one end from top to bottom and forked out as it is needed.

BEET-TOP SILAGE FOR BEEF CATTLE

While beet-top silage is usually less valuable pound for pound than corn silage, it is quite a satisfactory substitute in maintaining and fattening beef cattle. A definite comparison is difficult to make on account of the variable water content of both products. When cattle are fed a predominating sugar-beet byproducts ration consisting of about 25 pounds of beet silage, 60 pounds of siloed beet pulp, 10 pounds of alfalfa hay, 4 pounds of discard beet molasses, and about 3 pounds of cottonseed cake, as a daily feed per 1,000 pounds of live weight, they usually make an average daily gain ranging from 2 to 2½ pounds per head. For maintenance, about 25 pounds of beet-top silage and 10 pounds of alfalfa hay per 1,000 pounds live weight make a good ration. If alfalfa is not available, from 10 to 15 pounds of oat straw may be used.

BEET-TOP SILAGE FOR SHEEP

Beet-top silage is not generally fed to sheep, and such feeding tests as have been conducted with this feed have shown it to be unsatisfactory as a succulent feed for lambs. It causes digestive disturbances, and considerable scouring is likely to occur. In one experiment conducted at the Colorado Agricultural Experiment Station 1 pound of beet-top silage was not as good as 1 pound of corn or sunflower silage or 3 pounds of wet pulp when fed with a pound of grain and 1⅔ to 2 pounds of alfalfa hay.

BEET-TOP SILAGE FOR DAIRY CATTLE

It is believed by some dairymen that beet tops cannot be fed to dairy animals in any manner except as beet-top silage if the production of off-flavored milk is to be avoided. Where used, it is generally

fed following milking, a daily ration of about 25 pounds of silage, 10 pounds of legume hay, and about 7 pounds of grain and dried-pulp mixture being used per 1,000-pound animal giving about 25 pounds of milk daily.

PULP

In the process of beet-sugar manufacture the beet is sliced in the factory into long, thin, angular slices called "cossettes" and extracted with warm water, to dissolve out the sugar known as "sucrose." The fibrous mass which remains after extraction is called "pulp" and contains from 5 to 9 percent of dry matter, the remainder being water. The amount of pulp produced per ton of beets sliced usually varies in direct proportion with the richness of the beet, being generally higher in higher testing beets, and lower in lower testing beets, the yield of marketable wet and siloed pulp ranging from 20 to 30 percent of the weight of beets purchased.

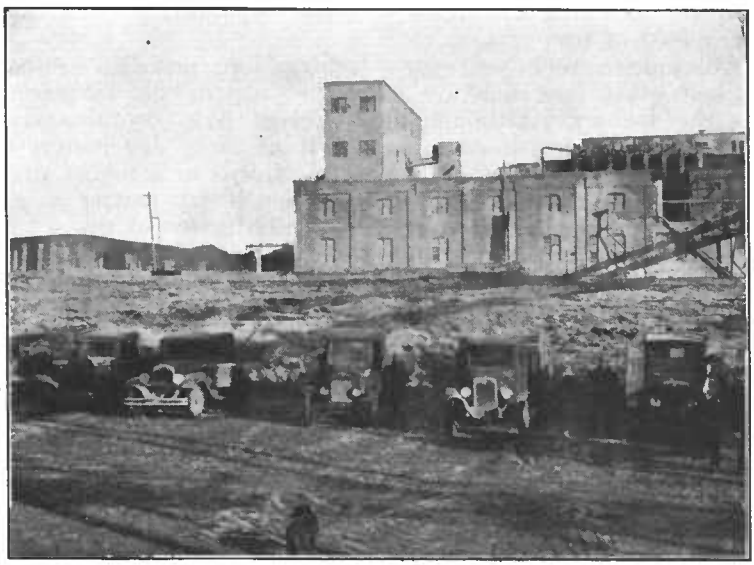

FIGURE 6.—Beet-sugar factory with basin silo and trucks for hauling siloed pulp.

In some factories the wet pulp is pressed through rollers to squeeze out a certain amount of excess water to reduce the cost of transportation. The resulting product is known as pressed beet pulp and contains about 15 percent of dry matter. Beet-sugar factories not equipped with pulp-drying equipment, or those not desiring to dry their entire output of pulp, store the excess pulp in huge pits commonly called pulp silos, where the fresh unpressed pulp undergoes fermentation and results in a product known as "siloed pulp." This fermented pulp appears to be as palatable as the fresh pulp and is more satisfactory to feed, as it does not freeze quite so quickly when it is being handled in cold weather.

The dry-matter content of the pulp increases gradually during the storage period from about 8 percent in September to 10 percent in November, to 12 percent in January, and 14 percent in April. In

selling pulp to farmers the price charged is gradually increased to correspond to the concentration which occurs.

Wet pulp and siloed pulp are distributed to feeders within a short hauling distance by truck or wagon from the factory. The siloed pulp is in great demand because of its feeding value and is hauled throughout the feeding period to feed lots within reasonable hauling distance of the factory (fig. 6). Pressed pulp is mostly shipped out by rail to feeders within a radius of approximately 10 to 50 miles.

At the Colorado Agricultural Experiment Station it was found that, although the wet-pulp recovery from factory silos amounted to about 25 percent of the weight of beets purchased, the wet-pulp allotment or the amount the beet grower was allowed to purchase usually ran from 15 to 45 percent of the beet tonnage delivered, depending on the proximity of the beet-producing area handled by the factory and on the local demand for pulp. Under this allotment the average feeder received 75 to 225 tons of pulp, which was often insufficient for a complete fattening operation without the addition of a supplementary feed of like nature.

In Colorado in recent years some factories have installed equipment for pressing the free moisture from the pulp in cold presses as it leaves the factory. Although this pressed pulp contains only 5 percent less moisture, it contains one third more dry matter than ordinary wet pulp. In other words, two thirds of a ton of pressed pulp (85 percent moisture) contains as much dry matter as a ton of wet pulp (90 percent moisture). The production of pressed pulp enables the different factories to maintain a more uniform allotment figure, as the pressed pulp is better adapted to shipment and widens the pulp-feeding territory. Where siloed pulp was once used within a radius of 3 or 4 miles of the factory, it is now trucked as far as 16 miles and is shipped by rail even farther.

FEEDING WET PULP

Studies were made at the Colorado Station to determine the relative value of wet pulp siloed at the factory and pressed pulp siloed on the farm. A summary of two tests shows that wet pulp hauled from the factory silo and paid for on a factory standard-shrinkage basis gave a profit of $1.85 per ton fed, while pressed pulp stored on the farm gave a profit of $1.33. In fattening calves for 194 days equal quantities of pressed beet pulp and siloed beet pulp had the same feeding value. The average ration was 26 pounds of pulp, 4 pounds of ground barley, 1.1 pounds of cottonseed cake, and 6 pounds of alfalfa hay.

The principal advantage in the pressed pulp appears to be its greater adaptability for shipping and storage which thus widens the pulp-feeding area. Studies at the station have indicated that an ordinary trench silo is most efficient in storing pressed pulp on the farm. A trench silo 5 feet deep, 12 feet wide, and 100 feet long holds 150 tons of pressed pulp.

A straw silo of the same capacity, constructed with 12-foot posts, 5-foot woven wire stretched on either side of the posts, and straw packed in between, costs nearly four times as much as the trench silo.

There was a 27 percent loss of weight on pulp stored in the trench silo, a 28 percent loss on pulp stored in the straw silo, and a 34 percent loss on pulp stored in an open pile on the ground. Many feeders pile a portion of the pulp they haul from the factory silo, and trench silos would pay where any considerable amount is stored.

The analysis of sugar-beet pulp as given in table 1 does not show all of its value as a feed in a properly balanced ration, because it is very palatable, stimulates the digestive processes, and gives livestock a more thrifty appearance. Generally, pulp-fed cattle gain as well as or better than cattle fed on corn silage, are sleeker, and sell fully as well. In addition, the crude fiber of root crops is more digestible than that of other forage plants at the time they are usually harvested for feed.

TABLE 1.—*Comparison of digestible nutrients in the concentrates, barley and dried beet pulp, and in the roughages, alfalfa and timothy hay*[1]

Kind of feed	Water	Ash	Crude protein	Carbohydrates		Fat or ether extract	Digestible protein	Digestible carbohydrate equivalent
				Crude fiber	Nitrogen-free extract			
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Barley	9.6	2.9	12.8	5.5	66.9	2.3	10.4	63.8
Fresh beet pulp	90.5	.4	.9	2.2	5.8	.2	.5	7.1
Dried beet pulp	8.4	3.5	9.3	18.7	59.3	.8	4.9	66.0
Alfalfa hay	8.3	8.9	16.0	27.1	37.1	2.6	11.5	42.0
Timothy hay	12.5	5.4	6.8	28.3	44.3	2.7	3.3	44.7

[1] Compiled by the Cereal Section, Food and Drug Administration, and the Animal Husbandry Division, Bureau of Animal Industry, U.S. Department of Agriculture. The carbohydrate equivalent is the sum of the digestible crude fiber and nitrogen-free extract plus 2.25 times the digestible fat.

The results of a great many experiments and the experiences of livestock feeders, in general, prove that a pound of dry matter in beet pulp is equal to a pound of dry matter in grain, and that a pound of dried beet pulp or dried-molasses beet pulp is equal to a pound of grain in a properly balanced ration. Being largely a carbohydrate feed like the grains, and quite deficient in protein, lime, and phosphate, it should be fed with legume hay, such as alfalfa, and oil-mill byproducts, such as cottonseed or linseed meal.

Until recent years, rations of wet beet pulp with hay or straw were used to fatten mature cattle and sheep. Such rations are too bulky for good results with younger stock. By adding concentrates, such as grain and cottonseed cake, beet byproduct rations have been developed that are as effective in the fattening of calves, yearlings, and lambs as in the fattening of older stock.

WET BEET PULP FOR BEEF CATTLE

Nearly 20 years of experimental feeding work at the Colorado Station shows that there is no fattening ration for cattle that will produce as cheap or satisfactory gains as a ration containing a liberal amount of wet beet pulp. Calves fattened on a ration of ground barley, cottonseed cake, and alfalfa hay gained 1.83 pounds per head daily at a feed cost of $10.01 per hundredweight of gain. The addition of 14 pounds of corn silage to this ration produced a gain

of 1.85 pounds per head daily at a feed cost of $9.76 per hundredweight of gain. The addition of 28 pounds of wet beet pulp instead of 14 pounds of silage produced a daily gain of 1.91 pounds per head and at a feed cost of only $8.49 per hundredweight.

Ordinarily the addition of protein concentrates causes such a marked increase in gain that the feed cost per unit of gain is actually reduced. In one Colorado experiment the addition of 3 pounds of cottonseed cake to a ration of wet beet pulp, beet molasses, and alfalfa hay increased the daily gain on 3-year-old steers nearly 1 pound (1.54 to 2.48) per head daily and reduced the cost of gain nearly $2 per hundredweight ($11.98 to $10.08). Linseed cake did not prove as efficient as cottonseed cake in such tests. Each ton of cottonseed cake fed replaced 15.7 tons of wet beet pulp, 1 ton of molasses, and 2.8 tons of alfalfa. Even with the low values used of $1.50 per ton for pulp, $15 per ton for molasses, and $10 per ton for hay, the cottonseed cake showed a feed-replacement value alone equal to $66 per ton and in addition enhanced the value of the finished cattle 25 cents per hundredweight.

The Montana Station has obtained similar results from the use of cottonseed cake fed with beet byproducts to cattle.

Recent experiments at the Colorado Station indicate that in fattening calves on an average ration of 2.4 pounds of barley, 2.4 pounds of corn, 25 pounds of wet beet pulp, 7 pounds of alfalfa, and 0.02 to 0.03 pounds of mineral mixture, one half pound of cottonseed cake was better than 1 or 1½ pounds of cake, considering rate and economy of gain, sale price, and proceeds.

Barley fits well in the beet-growing rotation and has proved practically equal to corn when used in beet-byproduct rations containing a good variety of feeds. Barley fed in limited amounts with beet pulp does not have the tendency to cause the bloat which is characteristic of feeding it in large amounts with hay alone in the Northwest. It should always be coarsely ground or rolled for cattle.

For calves a good rule is to feed about 1 pound of barley for every 100 pounds the animal weighs along with 1 pound of some protein-rich concentrate, about 5 pounds of alfalfa hay, and a full feed of wet beet pulp, usually about 30 pounds. Older cattle having a greater capacity for wet beet pulp should do well on less barley in proportion to their weight.

Where there is a limited allotment of wet beet pulp and a limited supply of alfalfa hay, there is the problem of providing some cheap bulky feed for the fattening ration.

Colorado experiments show that corn silage fed mixed with wet beet pulp at the rate of one third silage and two thirds pulp produced more expensive gains than pulp alone but cheaper gains than a ration of grain, hay, and cottonseed cake. Although corn silage is neither as cheap nor efficient as wet beet pulp, it ranks next to pulp in low cost as a bulky succulent feed and can be used to advantage in supplementing a limited supply of pulp. Siloed beet pulp (89 percent water) is estimated to have about half the value of good corn silage.

While cull potatoes are less palatable than wet pulp, and calves will not do as well on a full feed of them, a mixture of two thirds pulp

and one third cull potatoes has given as good results as a full feed of pulp.

There are several rations that find favor among cattlemen in the beet-producing areas where cattle are fattened. Some prefer to feed all of the wet or siloed pulp the cattle will consume, and a mixture of about 8 to 10 pounds of hay and straw finely chopped, 4 pounds of molasses, and 2 pounds of cottonseed cake per head. Experiments have proven that such chopping of good roughages generally does not pay. Others make a practice of feeding 5 to 10 pounds of grain per head and a full feed of wet or siloed pulp and hay. When the hay is fed whole, grain, molasses, and cake may be scattered over the pulp.

WET BEET PULP FOR SHEEP

Wet pulp is an excellent feed for fattening lambs, as it tends to increase gains and reduce digestive trouble and death losses. As a result of 6 experiments at the Colorado Station, it was found that 1 ton of wet beet pulp was equal to 115 pounds of shelled corn and 358 pounds of alfalfa hay in producing gain in fattening lambs. The statements relative to use of concentrates, legume hay, and oil-mill byproducts to supply protein and other nutrients in fattening cattle apply generally in the same degree to sheep. However, barley should be fed whole. Generally, the practice is to feed the hay first and then place the pulp on top of the remaining hay. In doing this, the pulp softens the coarse left-over stems, making them more palatable, inducing the lambs to clean up the pulp and hay refuse before the late-afternoon feed of hay.

On account of the bulky nature of wet beet pulp and the high nutritive value of its dry matter it may be used as a partial substitute for either grain or hay or both in fattening lambs. In addition, the use of it usually results in a greater quantity of dry matter being consumed than would be were it not fed. Often as much as one third to one half of the hay is replaced by wet pulp. Lambs should be started on about 1 pound of pressed pulp per day and may be increased to a full feed, about 6½ pounds, in 25 days. To get them on a full feed of grain requires about 30 days.

Some feeders prefer wet beet pulp for feeding sheep because the moisture in the pulp lessens the need of having water for them to drink. According to two experiments conducted by the Wyoming Agricultural Experiment Station, lambs that were not watered ate and gained slightly more, but the gains were a trifle less economical.

At the Belle Fourche Field Station, Newell, S.Dak., the advantages of adding a protein supplement such as cottonseed or linseed cake to a ration of alfalfa hay and pressed pulp are clearly shown in considerably larger gains and higher selling price. Eighty-three pounds of cake replaced 553 pounds of pulp and 276 pounds of hay.

In the intermountain region approximately 4 pounds of wet pulp is generally fed either in trough or through panels to lambs, it being estimated that 4 pounds of wet pulp replace 1 pound of alfalfa hay or one half pound of grain. Some sheepmen value wet pulp as a conditioner for bred ewes before lambing. After lambing, about 5 pounds of wet pulp, one half pound of grain, and 2 pounds of

alfalfa hay make an excellent ration for producing a good flow of milk.

In Colorado, some feeders prefer feeding wet beet pulp in troughs while others feed wet pulp along the panel (fig. 7) and dried pulp (either plain or dried molasses pulp) in the troughs. In either case from 2 to 3½ pounds of wet pulp and one fourth of a pound of dried pulp are fed per animal at each of two feedings. The wet pulp is fed to the lambs early in the morning and is followed by a feeding of grain and hay. As the wet pulp is usually a cheaper source of dry matter than hay, it is the general practice to limit the hay to 1 pound per head daily and to full-feed grain and pulp in order to get rapid gains at a reasonable cost.

FIGURE 7.—Lambs feeding on beet pulp through panels.

WET BEET PULP FOR DAIRY CATTLE

Information on the feeding of sugar-beet pulp to dairy animals is available from two sources, namely, general feeding practices and experimental work. Much information on the feeding of wet sugar-beet pulp to dairy animals has been obtained from the general practices of dairymen located in close proximity to sugar factories. These dairymen have come to depend on sugar-beet pulp, largely because they found in this byproduct a valuable source of succulent feed for their dairy animals. Many of these dairymen grow only enough corn for silage purposes to insure an ample supply of succulent feed, since frequently the amount of pulp allotted them by the sugar company is insufficient to meet the requirements of their herds. The reports on the use of beet pulp in the main have been favorable.

According to the Colorado Agricultural College, beet pulp produces good milk when not fed excessively. Excessive feeding without proper supplements, such as bone meal and legume hays, may result in the production of weak calves because beet pulp is very low in lime, which is vital to the production of healthy calves. Three pounds of wet beet pulp is equal in feeding value to about 1 pound of silage or 1½ pounds of sugar beets for dairy cows. Its very low protein content makes it necessary to have a leguminous hay in the ration or some high protein concentrate, such as cotton-

seed meal. Wet beet pulp should not be fed in the barn because its odor may affect the milk. It is advisable to feed the pulp soon after milking, taking the cows away from the feed at least an hour before they are to be milked.

Experimental work recently conducted in feeding tests in which wet sugar-beet pulp and corn silage were compared is of interest. The Utah Agricultural Experiment Station has recently reported the results of a feeding trial extending over a 4-year period. In this trial two groups of cows were fed the following ration: The group that was fed wet beet pulp consumed on an average 68.1 pounds of wet pulp, 20.3 pounds of alfalfa hay, and 5.4 pounds of grain per head as a daily ration, and the group of cows fed corn silage consumed 32.1 pounds of silage, 20.9 pounds of alfalfa hay, and 4.5 pounds of grain per head per day. From this it will be noted that there was little difference in relative economy in hay consumption between the two rations used. It was found that 2.1 pounds of wet beet pulp with an average dry-matter content of 11.5 percent was required to replace 1 pound of corn silage with an average dry-matter content of 26 percent. The average daily production of milk per cow during the four winter periods was 23.5 pounds containing 0.77 pound of butterfat for the silage group, while the pulp group produced 27.9 pounds of milk containing 0.91 pound of butterfat or 4.4 pounds of milk and 0.14 pound of butterfat more per day than was produced per cow in the silage group. It is considered that this average difference of 18.7 percent in milk and 18.2 percent in butterfat in favor of the pulp-fed group of cows is not due to the different rations, but rather to the condition of the cows in the silage group. These cows carried calves for 0.15 day longer for each day they were in the experiment, and gained 0.16 pound more in weight per head per day than did those in the pulp group. The cost of producing 100 pounds of milk for the pulp-fed group of cows was slightly higher than for the group fed corn silage. This difference was due to the high tonnage of corn produced per acre; otherwise the cost could easily be reversed.

During the four summer periods there was no significant difference in milk and butterfat production between the corn-silage and wet-pulp groups, the same being likewise true of the health of the calves dropped by the two groups of cows. It was observed, however, that the cows in the pulp group developed what seemed to be a tenderness of the hind limbs and a tendency to lick board fences and at times to chew at sticks. No cause was assigned for this condition. This observation calls to attention the desirability of further experimentation with this class of feeds in various localities, looking toward the determination of desirable supplements such as minerals high in phosphorus or steamed bone which may correct any deficiency that may exist in the ration.

WET BEET PULP FOR HORSES AND SWINE

While 20 to 40 pounds of wet beet pulp may be fed to idle horses when properly supplemented with dry roughage, it should not be fed to work horses. The Utah Station reports that colts had constant access to pulp at a sugar factory for several years without any bad results.

Beet pulp is not extensively used in feeding swine. In an experiment carried on by the Utah Station 609 pounds of wet beet pulp fed at the rate of 12.3 pounds per head daily replaced 100 pounds of shorts in fattening pigs.

FEEDING DRIED PULP

The pulp-drying equipment of beet-sugar factories consists of slowly revolving drums in which the heat from furnaces is regulated in accordance with the quantities of wet pulp entering the drums. The dried beet pulp, which usually contains less than 10 percent of water, is usually bagged as soon as it comes from the drums, although at some factories a quantity is stored in bulk to supply the local trade. The yield of plain dried pulp produced ranges from approximately 4.5 to 5 percent of the weight of beets purchased. Frequently beet molasses is added to the dried pulp, and the pulp is then sold as dried molasses pulp.

The dried beet pulp and dried molasses pulp are popular feeds, since they can be stored under proper conditions for considerable periods without deteriorating and can be transported long distances, like many other kinds of feed. They can be used to advantage as bulky concentrates to lighten rations of heavy concentrated feeds. The amount being disposed of locally is increasing.

It has been shown that dried beet pulp has a much higher feeding value when fed mixed with corn or barley or fed with corn silage or corn fodder or cottonseed cake than when fed as a lone concentrate. Fed alone with alfalfa in three tests at the Colorado Station, it showed only 75 percent of the feeding value of corn; mixed equal parts with corn, it showed 97.8 percent of the value of corn. Both beet pulp and dried molasses pulp have more of a tendency to produce growth in a fattening ration than corn does.

Dried molasses pulp has about the same feeding value as dried beet pulp but is somewhat more laxative. It usually contains about 25 percent of beet molasses. For winter or spring feeding of livestock on the range, dried molasses pulp alone and cottonseed cake and dried molasses pulp have been placed on the market in pellet form for feeding on the open ground or on the snow, and to avoid loss by wind. Another advantage claimed for dried beet pulp when fed to livestock is the greater consumption of water. In a particular case where it was desirable to induce stallions to drink about midnight this result was obtained by feeding dried beet pulp as a part of the grain ration.

DRIED BEET PULP FOR BEEF CATTLE

As dried pulp is more bulky than corn or barley, it is less suited to getting a high finish than such grains. If pulp and corn are to be fed it is well to feed a larger proportion of the pulp early in the fattening period and more of the corn in the latter part. In comparing dried pulp and dried molasses pulp with oats for fattening steers, English investigators found them practically equal, but the pulp-fed cattle were more contented. While the fat from pulp feeding was slightly softer, there were no objections from the butchers and apparently no differences in the texture of the meat.

According to the Michigan Station, 10 pounds of dried beet pulp per 1,000 pounds of live weight is about the limit for cattle being fattened.

In fattening calves on barley and alfalfa hay at the Colorado Station, 4.3 pounds of barley and 20 pounds of siloed pulp gave slightly better results than 3.8 pounds of barley and 3.4 pounds of dried pulp. This indicates that 6 to 7 pounds of siloed pulp are equivalent to 1 pound of dried pulp. In a similar experiment, it required about 8 pounds of siloed pulp to equal 1 pound of dried pulp.

The Colorado Station also reports that 1 pound of dried beet pulp is equal to 1 pound of corn or 2.8 pounds of alfalfa hay for fattening 2-year-old steers. For the most satisfactory gains, both grain and dried pulp should be fed with legume hay.

According to findings of the Colorado station, a ton of dried molasses pulp when fed mixed half and half with corn replaces 1,665 pounds of corn and 640 pounds of alfalfa hay or has 95 percent of the feeding value of corn.

DRIED BEET PULP FOR SHEEP

In the West there have been heavy losses of lambs on a full feed of corn such as 1 pound per head daily. Such losses are greatly reduced by feeding a 50–50 mixture of dried molasses pulp and corn. Some men prefer to feed 3 parts of corn and 1 part of dried beet pulp, while others feed dried beet pulp with barley, using one third pound of dried pulp to 1 or 1¼ pounds of barley.

According to the Michigan Station, sheep prefer dried molasses pulp to plain dried pulp. This station has also reported that while both products compare very favorably with corn in feeding value they tend to produce more growth and less fat than corn.

At the Belle Fourche Field Station three experiments in fattening lambs showed that 100 pounds of dried pulp replaced approximately 110 pounds of barley when half barley and half dried pulp instead of all barley were fed with cottonseed cake and alfalfa hay. The substitution of dried pulp for half of the barley did not affect the rate of gain or the sale price.

At the same station the advantage of adding a protein supplement such as cottonseed or linseed cake to a ration of dried pulp and alfalfa hay was clearly shown. The cake-fed lambs gained much more per head (8 to 10 pounds) and sold slightly better than the lambs getting no cake. Averaging the three experiments, 68 pounds of cake reduced the feed requirements per 100 pounds of gain by 164 pounds of dried pulp and 253 pounds of hay. In other words, when 68 pounds of cake are as cheap as or cheaper than 164 pounds of pulp and 253 pounds of hay, the indications are that the purchase and feeding of the cake will be profitable.

The average of three experiments at the Scotts Bluff Field Station, Mitchell, Nebr., shows that in fattening lambs equal parts of corn and dried pulp, and corn alone, when fed with alfalfa hay are practically equal in value. As the proportion of dried pulp is increased above 50 percent, the rate of gain of the lambs decreases, and the quantity of feed required per unit of gain increases. At the same station, increasing cottonseed cake per 25 lambs daily from 2 to 10

pounds with 32 pounds of dried pulp increased the rate of gain and reduced the requirement per 100 pounds. When 8 pounds and 10 pounds were fed, the selling price rose from $6.75 to $7. With pulp $12, cottonseed cake $25, and alfalfa $7 per ton, it was profitable to feed more cottonseed cake.

DRIED BEET PULP FOR DAIRY CATTLE

Dried beet pulp or dried molasses pulp are extensively used in feeding dairy cattle. They may be fed either in dry form or moistened. Dried beet pulp soaked in about three times its weight of water makes a good substitute for other succulent feed. However, it is usually more expensive than silage. The soaked beet pulp is also valuable as a feed for high-producing cows. Frequently the grain requirement for such cows is so high that the necessary quantity cannot be fed without endangering their health. In such cases the quantity of grain may be kept at a safe level and the additional nutrients supplied by feeding beet pulp.

Some of the intermountain dairymen feed a one fourth dried molasses pulp and three fourths grain mixture consisting of oats and barley, the total amount of the mixture fed ranging from 4 to 12 pounds daily, depending on milk production. The milking cows are fed alfalfa hay at will, whereas the dry stock is fed hay and straw sprinkled with 1 to 2 pounds of molasses mixed half and half with water. When fed dry, it is customary to mix the pulp with the grain in the proportion of 3 parts grain to 1 part of dried pulp and feed at the rate of 1 pound of this mixture to 4 pounds of milk produced. Many dairymen prefer dried molasses pulp which they feed with grain, making a mixture of 1 pound of dried molasses pulp to 3 pounds of the grain (which frequently consists of oats and barley), the total amount of the mixture fed ranging from 4 to 12 pounds per head daily, depending on milk production. These dairymen are of the opinion that dried molasses pulp is equal to grain when fed in a ration. The milking cows are fed alfalfa hay at will, whereas the dry stock is fed hay and straw sprinkled with 1 to 2 pounds of molasses diluted one half with water.

There is a prejudice among dairymen against pulp that is dark-colored, which seems to be unwarranted as the dark color is due to the addition of molasses, and, as experiments show that both plain dried pulp and dried molasses pulp have practically the same feeding value, the discrimination is not justified. While the dried molasses pulp commonly contains 20 to 25 percent of molasses, some dairymen prefer pulp with as much as 40 percent of molasses. Ordinarily one should use the pulp that can be bought most cheaply.

The Ohio Experiment Station, in reporting the results of a series of tests in feeding cows where corn silage and dried beet pulp soaked and flavored with molasses had been used as a corn-silage substitute, concluded that while the groups of cows fed dried molasses pulp showed an increase of 9.3 percent in milk production and 3.4 percent in butterfat, on the basis of feed consumed, the dried molasses pulp ration cost sufficiently more than the corn-silage ration to make feeding it uneconomical when corn silage could be produced at moderate cost.

In a test conducted cooperatively by the Division of Dairy Cattle Breeding, Feeding, and Management, Bureau of Dairy Industry, and the Utah Experiment Station, the results show that when 100 pounds of dried molasses pulp replaced 50 pounds of barley and 50 pounds of wheat bran in the grain mixture there was no significant decrease in production of milk. The cows were fed as much alfalfa as they would consume; corn silage was fed on the basis of 2½ pounds per day per 100 pounds live weight of the cows. Grain was fed on a basis of 1 pound per day for each pound of butterfat produced in 7 days. All cows had access to salt and steamed bone meal fed in boxes under the shed. The average daily milk production of the cows when fed the barley and wheat-bran mixture was 27.6 pounds per day, and 26.5 pounds of milk were produced when cows were fed a mixture of barley, wheat bran, and dried beet pulp. It is indicated by this test that with dairy cows dried molasses pulp is equal to a mixture of chopped barley and wheat bran, equal parts by weight, for milk production.

DRIED BEET PULP FOR HORSES

While dried beet pulp alone is not palatable to horses, as much as 5 pounds per head may be mixed with molasses or other well-liked feeds and be included in the ration to good advantage. As beet pulp is low in protein, the ration should include some feed which is relatively high in protein.

MOLASSES

In the manufacture of beet sugar the solution of sugar extracted from the sliced raw beets is evaporated until a sirup is formed, and the maximum amount of sugar has been crystallized. Then the crystals are separated from the mother liquor by centrifuging. There is still much sugar remaining in the mother liquor, which is reworked several times to recover as much of the crystallized sugar as can profitably be extracted in this manner. The residue is called molasses. In those beet-sugar factories where the Steffens process is used, the molasses is "limed" to extract more sugar. This is known as Steffens or foreign-discard molasses. There is still another process, in which barium is used instead of lime, by which the recovery of sugar from the Steffens molasses is carried on still further. The residue from this process, which is known as final discard, is much less than that from the Steffens process, and compares very favorably in feeding value with Steffens molasses.

The final-discard molasses has a bitter taste. In addition to its customary quota of sugar, it contains from 10 to 15 percent of raffinose, which increases its carbohydrate content accordingly. In recent lamb-feeding tests at the Colorado Station this final-discard molasses proved more palatable than any of the others, including cane.

Beet molasses, while of great value industrially in the manufacture of alcohol and in the manufacture of yeast for human and animal consumption, is used chiefly at present in livestock feeding. It is also very useful as an appetizer in poison-bran mashes for controlling certain insect pests. The molasses insures the retention

of moisture and the proper crumbling consistency of the mash. Beet molasses is classed as a concentrate, having generally less than 20 percent of moisture. It is sold either in tank-car lots or in barrels. Farmers near the factories may effect a saving by furnishing their own containers. Some use tank wagons or trucks. Metal containers are generally preferred, as there are no seams through which the molasses can leak.

The composition of molasses varies greatly, depending not only upon the source and character of the beets and the control of the process at the factories at which it is produced, but also upon different periods of the sugar campaign. Table 2 gives the composition of molasses not "Steffenized" in comparison with cane molasses, barley, and corn. The carbohydrates consist mainly of sugars (sucrose plus approximately 0.5 percent of invert sugar). In the latter part of the factory operations there may be up to 1 percent or more of the sugar known as raffinose in the molasses. In some factories, the Steffenized molasses may contain an even higher percentage of carbohydrates. The mineral matter consists of sulphates, chlorides, nitrates, and phosphate. Compounds of potassium constitute from one third to one half of the total mineral matter.

TABLE 2.—*Analysis of beet molasses, cane molasses, barley, and corn* [1]

Kind of feed	Water	Ash	Crude protein	Carbohydrates		Fat or ether extract
				Crude fiber	Nitrogen-free extract	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Beet molasses	20.8	10.6	9.1	-------	59.5	-------
Cane molasses	24.0	6.8	3.1	-------	66.1	-------
Barley	9.6	2.9	12.8	5.5	66.9	2.3
Corn	12.9	1.3	9.3	1.9	70.3	4.3

[1] Compiled by the Cereal Section, Food and Drug Administration, and the Animal Husbandry Division, Bureau of Animal Industry, U.S. Department of Agriculture.

MOLASSES FOR BEEF CATTLE

On account of its unusual palatability, molasses usually adds more to a ration than its composition would indicate. Beet molasses should be introduced gradually into fattening rations, starting with about one half pound per head daily, in order that the digestive system may become accustomed to the salts which it contains. In hand-feeding, the molasses is usually sprinkled on the wet beet pulp or is spread in the trough and covered with grain. In self-feeding, it should never be fed warm.

There is considerable to be said in favor of feeding molasses on the coarser and less palatable roughages that farmers usually have, as it is an efficient method of using material which might not otherwise be eaten. However, molasses must be fed with care in hot weather, the amount fed to large cattle being reduced from 3 or 4 pounds daily to 1 pound, and corresponding reductions made for other livestock. Some feeders prefer to self-feed molasses, allowing

the animal free access to the molasses at all times (fig. 8). In the case of 3- to 4-year-old cattle as much as 8 to 9 pounds per day may be consumed during cold weather without bad effects.

In fattening steers at the Colorado Station, 100 pounds of beet molasses replaced 79 pounds of barley, 77 pounds of corn silage, and 33 pounds of alfalfa hay in one experiment and 47 pounds of barley, 125 pounds of sunflower silage, and 47 pounds of alfalfa hay in another. Averaging several experiments in fattening cattle, the Colorado Station concludes that beet molasses when fed in limited amounts has about 88 percent of the feeding value of corn, pound for pound.

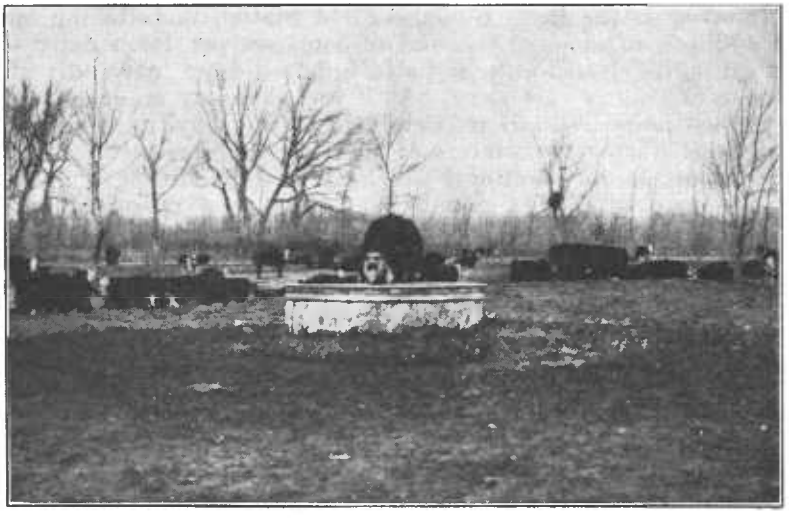

FIGURE 8.—Steers having free access to beet molasses. They will eat as much as 6 pounds of molasses per head per day without bad aftereffects.

MOLASSES FOR SHEEP

Beet molasses has about 85 percent of the feeding value of grain when fed with grain and alfalfa to lambs. The Colorado Experiment Station states that greater efficiency for feeding beet molasses is indicated when smaller amounts are fed. In hand-feeding, the molasses is usually spread from the buckets in the grain troughs and then covered with grain, so that the lambs get a small amount of molasses with each mouthful of grain. Wasting the molasses is thereby avoided, as the lambs are kept much cleaner than where molasses is spread over the grain.

Beet molasses may also be mixed with water and spread over alfalfa or other roughages, or it may be used as a part of a ground-hay mixture. In such a mixture there is about 20 percent of molasses. Some feeders prefer to self-feed molasses, in which case the lambs should be gradually accustomed to it. It is better to hand-feed the lambs for 4 or 5 weeks with the grain and molasses mixture before starting self-feeding on molasses. Lambs will eat as much as 1¼ to 1½ pounds of molasses daily when self-fed. However, the wool is apt to get very dirty.

Lambs hand-fed on grain and alfalfa are generally started on one tenth of a pound of molasses daily, which is gradually increased to one fourth pound at 15 days and one half pound in 30 to 40 days.

A 4-year comparison of shelled corn and alfalfa hay with shelled corn, beet molasses, and alfalfa hay for fattening lambs at the Colorado Station showed slightly greater daily gains (7 percent) and a saving of 59 pounds of corn and 74 pounds of alfalfa hay for each 100 pounds of molasses fed. Two experiments conducted by the Wyoming Station showed that the addition of one fourth of a pound of molasses daily to a ration of corn and alfalfa increased the rate of gain 10 percent, and 14 percent when added to a ration of barley and alfalfa.

However, at the Belle Fourche Field Station in fattening lambs the addition of about 0.4 pound of molasses per lamb daily to a full ration of pressed pulp and alfalfa hay did not materially affect the rate of gain or sale price. As it replaced only an equal weight of pressed pulp and half its weight of alfalfa hay, its use was not economical during the winters of 1927 to 1931, inclusive. In three experiments at the Huntley Field Station the addition of molasses (about one fourth of a pound per head) to a ration of barley, cottonseed cake, wet pulp, and alfalfa hay increased the cost of gain and cut the rate of gain and profits. Therefore, it is concluded that the addition of molasses to a fattening ration containing considerable wet pulp is not desirable.

Frequently questions are asked by feeders of livestock concerning the relative feed value of beet molasses and cane molasses. At the Colorado Station tests conducted with cane versus beet molasses for the feeding of lambs show that a ton of discard (Steffens) molasses replaced 1,043 pounds of shelled corn, but 55 pounds more hay were required as compared with cane molasses, which replaced 807 pounds of shelled corn but required only 8.5 pounds more hay. Several lamb-feeding experiments conducted at the Washington and Iowa agricultural colleges have shown that sugar-beet molasses is fully equal if not superior to cane molasses for fattening cattle and lambs.

MOLASSES FOR DAIRY CATTLE

The use of molasses on hay is endorsed by many of the dairymen of the intermountain region who feed about 2 to 3 pounds of molasses per cow per day sprinkled over the alfalfa and other roughages. When molasses is fed in these amounts the dairymen estimate that it has about 80 percent of the value of grain, pound for pound. When molasses is fed to breeding stock care must be exercised not to exceed 3 pounds daily. Some farmers mix molasses and water half and half in a large tank, because such a mixture will not freeze in coldest weather, always flows, is less sticky, and is easier to handle.

MOLASSES FOR HORSES AND SWINE

As a horse feed, beet molasses is not so satisfactory as cane molasses. The presence of certain salts stimulates the action of the kidneys and bowels of the animals fed. Because of this action it is not desirable to exceed 5 pounds of beet molasses in the daily ration. Like cane molasses, it is a carbohydrate concentrate, very palatable

and suitable for feeding as part of a concentrate in the ration that also includes a protein feed.

Molasses is not used much as a feed for hogs and should be mixed with concentrates when it is fed. Only a few experiments have been made with this feed for hogs, and they show a very wide variation in results, some being as low as about 60 percent of the feeding value of corn. In an experiment at the Utah Experiment Station, pigs weighing 139 pounds were fed for 48 days on an average ration of shorts 3 pounds, beet pulp 9.4 pounds, and beet molasses 4.4 pounds, and gained 75 pounds. Another lot fed 7.6 pounds of shorts daily gained 83 pounds per head.

Considerable caution should be practiced in feeding molasses to hogs. Feeding molasses to young pigs results generally in serious digestive disorders, and if it is fed to sows before farrowing the litters are apt to be weak. Practice seems to indicate that hogs should not receive any molasses until they weigh 125 pounds or more, and that then they should not be forced to eat it by mixing with other feeds, but allowed to get it at will from the trough. When fed to older hogs at the rate of 1 to 1½ pounds per day, molasses generally has somewhat less value than the same quantity of shelled corn.

MISCELLANEOUS BYPRODUCTS

MOTHER BEET ROOTS

Sugar-beet seed is now grown in several of the western and southwestern sections of the United States. After the seed is harvested in July, the mother beet roots that remain in the ground may be used for feed. These roots have considerable feed value as their sucrose content ranges from 5 to 8 percent or more. They should be plowed out of the ground and placed in a trench silo and fed as needed, or if desired they can be cut up in small pieces and ensiled. Such silage has a fattening value comparable to beet-top silage. Another practice followed is that of plowing out the roots, so that they will be readily available and then permitting livestock to graze on them. However, roots left exposed to the weather in this manner dry out rapidly and become very hard and fibrous, in which condition they may prove dangerous to livestock.

BEET TAILS

In transferring beets to and from the trucks or wagons at the dumps and in the storage bins and in various conveyors, some breakage of the "tails" results. The tails accumulate usually in catch basins and traps in the flumes of the factory. In addition, some beet tops that are caught by the automatic trash catcher in the flumes are mixed with the tails. From 2 to 4 tons or more of this refuse, depending on the slicing capacity of the factory, accumulates daily. This byproduct may be fed fresh or siloed. It has practically the same feeding value as fresh beet tops or beet-top silage.

LIME CAKE

In the process of extracting sugar from the sugar beet, and later, in reworking the molasses to extract more of the sugar, large quantities of burned limestone of very high calcium-carbonate content

are needed. The amounts used vary with the condition of the beets, the efficiency of the factory, and according to whether or not the Steffens process is used. If this process is used, the amount of burned lime required is increased considerably. The range varies from 4 to 6 percent or more of limestone used to the weight of the beets sliced. Using as a basis 8,000,000 tons of beets sliced and assuming that the consumption of limestone is 5 percent of the beets sliced, this would mean that the equivalent of at least 400,000 tons of dry lime cake would be produced when a crop of such size is processed. This lime cake (also known as factory lime, waste lime, filter press cake, and lime sludge) consists largely of calcium carbonate, contains some organic matter, and in its dry state compares favorably with the ground limestone sold for agricultural use. While some of this lime cake may be disposed of as sewage, the more general practice is to discharge this byproduct from the factory into large pits or settling basins from which it is removed periodically. In humid areas this byproduct may be placed in large piles to facilitate drainage and drying, and after a short time it is ready for shipment or for local use.

There are present in lime cake small amounts of phosphoric acid, nitrogen, and potash. Since lime cake is very finely ground it corrects the acidity of the soil more rapidly than the coarser ground limestone commonly sold for this purpose. Favorable results have been reported from its use in growing legumes, especially alfalfa, sweetclover, and red clover. The amount of lime cake which should be applied varies with the need for lime in correcting the acidity of the soil.

Lime cake has also been used with success on soils that have become compacted, as it tends to break up the soil and give it a granular structure. Whether used for improvement of soil texture or for correcting the soil reaction, lime cake should be applied broadcast on the field, either during the winter months or immediately prior to the seeding of legumes. In some factory districts where the value of the lime cake has been recognized, considerable quantities of this byproduct are sold at a very nominal cost per ton.

Lime cake has also been found to be of considerable value in certain areas when applied with irrigation water on reclaimed lands in close proximity to the factory, resulting in noticeable improvement in the soil condition and in increased yields of the succeeding crop. Because of the frequently demonstrated danger of spreading the sugar-beet nematode by this manner of disposal (occasioned by washing the nematode from the beet into the waste water at the factory) this method of spreading lime, in areas of known sugar-beet nematode presence, should be used with great caution if infestation of the land is to be prevented.

RATIONS AND FEED MIXTURES CONTAINING SUGAR-BEET BYPRODUCTS

In using a ration containing sugar-beet byproducts it is important to keep in mind that calves should be started on about one half pound per head daily of such concentrated feeds as cottonseed cake, molasses, and 2 or 3 pounds of grain or dried pulp,

and gradually increased to a full feed in about 30 days. Larger cattle may have more in proportion to their greater weight. However, older cattle are often fed a larger proportion of roughages, especially during the early part of the feeding period. The maximum quantity of concentrates per day fed during the latter part of the feeding period is usually about one third more than the quantities given in these suggested rations, which are an average for the whole period. The roughages and bulky feed such as wet pulp are full-fed from the beginning and are reduced toward the end of the fattening period. The same applies to sheep, except that they should be started on about an ounce of such concentrates as cottonseed cake and molasses and one fourth of a pound of grain or dried pulp.

RATIONS FOR BEEF CATTLE AND LAMBS

On the basis of experiments conducted at different experiment stations the following rations for fattening beef cattle and lambs are suggested:

BEEF CATTLE, COLORADO AGRICULTURAL EXPERIMENT STATION

Beef calves fed 200 days

	Pounds
Wet pulp	30
Beet molasses	2.5
Cottonseed cake	1.5
Alfalfa hay	14

Yearlings fed 190 days

Wet pulp	80
Beet molasses	3
Cottonseed cake	3
Alfalfa hay	8

Beef calves fed 90 to 120 days

Beet tops	14
Ground barley	2
Pressed pulp	14
Cottonseed cake	.5
Alfalfa hay	5

Yearlings fed 190 days

Corn silage	13
Dried molasses pulp	11
Cottonseed cake	2
Alfalfa hay	7

2-year-olds fed 160 days

	Pounds
Wet pulp	90
Beet molasses	3
Cottonseed cake	2
Alfalfa hay	10

3-year-olds fed 125 days

Wet pulp	90
Beet molasses	4
Cottonseed cake	2
Alfalfa hay	10

2-year-olds fed 110 days

Beet top silage	21
Dried molasses pulp	7
Cottonseed cake	2.5
Alfalfa hay	12

2-year-olds fed 110 days

Dried molasses pulp	10
Cottonseed cake	2.5
Alfalfa hay	13

LAMBS, BELLE FOURCHE FIELD STATION

	Pounds
Dried pulp	1.2
Alfalfa hay	2.1
Pressed pulp	6.0
Cottonseed cake	.2
Alfalfa hay	2.3
Dried pulp	.6
Barley	.6
Cottonseed cake	.2
Alfalfa hay	1.8

	Pounds
Dried pulp	1.0
Linseed cake	.2
Alfalfa hay	2.0
Pressed pulp	6.0
Alfalfa hay	2.4
Pressed pulp	5.6
Molasses	.4
Alfalfa hay	2.2

LAMBS, HUNTLEY FIELD STATION

	Pounds
Barley	1.0
Cottonseed cake	.2
Molasses	.3
Wet pulp	6.0
Alfalfa hay	1.5
Oats	1.1
Wet pulp	6.5
Alfalfa hay	1.9

	Pounds
Barley	1.1
Beet tops	2.3
Alfalfa hay	1.6
Barley	1.1
Wet pulp	5.8
Bean straw	1.3
Beet tops	1.8

RATIONS FOR DAIRY COWS

Dairy cows should be fed as much roughage as they will consume. The ration may include a moderate quantity of beet tops, wet beet pulp, or corn silage. Thirty pounds of fresh green beet tops or beet-top silage, 15 pounds of dried beet tops (cured and stacked), 50 pounds of fresh or ensiled wet pulp, or 30 pounds of corn silage is a desirable quantity to feed, per 1,000 pounds live weight, daily. Beet molasses not to exceed 3 pounds per 1,000 pounds live weight daily may be fed either in the grain mixture or sprinkled over the hay to render it more palatable. Ten or more pounds of dried beet pulp can be safely fed per cow per day. This may be fed dry as a regular ingredient of the grain mixture or fed after being soaked in 2 to 3 times its weight of water for several hours, to supplement the regular grain mixture. The use of dried beet pulp in the ration is thought to be desirable for high-producing cows being fed large quantities of grain.

These recommendations represent about the maximum quantities of beet pulp and beet molasses that it is desirable to use in grain mixtures. The quantity of grain to feed will vary with the quantity and quality of milk produced and the quantity of roughage consumed. Enough grain should be fed to maintain the milk flow and keep the cow in good condition. Cows producing medium or small quantities of milk and consuming large quantities of roughage need little or no grain. Cows producing large quantities of milk and consuming medium or small quantities of roughage will require considerable grain.

In regions where a good quality of alfalfa hay is available and where the cost of nutrients in dried beet pulp is lower than the cost of nutrients in grains, it has been found that alfalfa hay and the dried pulp make a satisfactory ration without the addition of grain.

DAIRY-FEED MIXTURES UTILIZING SUGAR-BEET BYPRODUCTS THAT ARE ADAPTED TO VARIOUS ROUGHAGES

Suggested grain mixtures with which different kinds and combinations of roughages are used are listed below.

Mixtures containing 11 to 12 percent total protein to be fed with alfalfa or other legume hay alone

Mixture no. 1:	Pounds
Dried beet pulp (plain or molasses)	400
Ground corn, oats, or barley	200
Wheat bran	200

Mixture no. 2:	Pounds
Molasses	100
Dried beet pulp (plain)	300
Ground corn, oats, or barley	200
Wheat bran	200

Mixtures containing 13 to 14 percent total protein to be fed with alfalfa hay and fresh or dried beet tops, beet-top silage, or fresh or ensiled wet pulp

Mixture no. 3 (feed with beet tops):	Pounds
Dried beet pulp (plain)	200
Ground corn, oats, or barley	200
Wheat bran	400

Mixture no 4 (feed with wet pulp):	Pounds
Molasses	100
Ground corn, oats, or barley	300
Wheat bran	400

Mixtures containing 15 to 16 percent total protein to be fed with alfalfa or other legume hay and corn silage; or mixed hay alone

Mixture no. 5:	Pounds
Dried beet pulp (plain or molasses)	300
Ground corn, oats, or barley	200
Wheat bran	200
Cottonseed meal	100

Mixture no. 6:	Pounds
Molasses	100
Dried beet pulp (plain)	200
Ground corn, oats, or barley	200
Wheat bran	200
Cottonseed meal	100

Mixtures containing 18 to 20 percent total protein to be fed with mixed hay and corn silage

Mixture no. 7:	Pounds
Dried beet pulp (plain or molasses)	300
Ground corn, oats, or barley	200
Wheat bran	100
Cottonseed meal	200

Mixture no. 8:	Pounds
Molasses	100
Dried beet pulp (plain)	200
Ground corn, oats, or barley	200
Wheat bran	100
Cottonseed meal	200

Mixtures containing 22 to 24 percent total protein to be fed with nonleguminous roughage, with or without corn silage

Mixture no. 9:	Pounds
Dried beet pulp (plain or molasses)	300
Ground corn, oats, or barley	100
Wheat bran	100
Cottonseed meal	300

Mixture no. 10:	Pounds
Molasses	100
Dried beet pulp (plain)	200
Ground corn, oats, or barley	100
Wheat bran	100
Cottonseed meal	300

In these grain mixtures, wheat, kafir, speltz, or hominy feed may replace part or all of the corn, oats, or barley. Linseed meal, peanut meal, or soybean meal may replace part or all of the cottonseed meal.

Using these mixtures as guides, the feeder of dairy cattle should work out a mixture that will be most economical under his conditions. The following rules furnish a guide for feeding grain or other concentrates (usually in the form of a grain mixture) to dairy cows, under most circumstances:

Feed a grain mixture in the proportion of 1 pound to each 3 to 4 pints or pounds of milk produced daily by the cow; or 1 pound of grain mixture for every pound of butterfat that the cow produces during the week.

Feed all the cow will respond to in milk production. When she begins to put on flesh above normal weight, cut down the grain mixture.

These mixtures for milk cows are also suitable for the feeding of yearling heifers. Heifers will consume proportionately less according to their weight.

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